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(72) Inventor: Eiichiro AOKI
c/o YAMAHA CORPORATION
No. 10-1, Nakazawa-cho, Hamamatsu-shi, Shizuoka-ken, Japan
(71) Applicant: 000004075
YAMAHA CORPORATION
No. 10-1, Nakazawa-cho, Hamamatsu-shi, Shizuoka-ken, Japan
(74) Agent: Patent Attorney, Masatake SHIGA

(54) [Title of the Invention] MUSICAL SOUND CONTROL DEVICE

Specification

1. Title of the Invention

Musical Sound Control Device

2. Claims

A musical sound control device comprising:

an acceleration detecting means for detecting an acceleration of a motion given to a performance control element and outputting an acceleration signal;

a pressure detecting means for detecting a pressure given to the performance control element and outputting a pressure signal; and

a control means for outputting musical sound control data for controlling a musical sound signal based on the acceleration signal and the pressure signal, and outputting musical sound control data

for damping the musical sound signal in the case that the acceleration signal or the pressure signal from the acceleration detecting means or the pressure detecting means is not output.

3. Detailed Description of the Invention

[Field of Industrial Application]

The present invention relates to a musical sound control device for controlling a music sound responding to a condition of a motion and pressure given to a performance control element.

[Conventional Art]

Recently, because of the improvement of technology, various kinds of musical sounds for sound sources of a musical sound control device can be obtained.

As one of the sound sources, various physical model sound sources are suggested, whereby making a model obtained from a simulation of the sounding mechanism of an actual natural instrument act, thus, a musical sound of natural instruments are synthesized.

Among the physical sound source models, as a physical model sound source of string instrument sounds (hereinafter refered to as a string-rubbing model sound source), one is known with a configuration of a nonlinear element simulating the elastic feature of a string and a delay circuit having a time delay corresponding to an oscillation period of a string are connected in a closed loop. Making this loop circuit in a resonance condition, a signal circulating in the loop is extracted as a musical sound signal of a string instrument.

In addition, this kind of technology is, for example, is disclosed in JP-A-Sho 63-40199 and JP-B-Sho 58-58679.

Further, in a physical model sound source used in the mentioned conventional musical sound control device, for example, among the parameters of a string-rubbing model sound source, a bow pressure is controlled in the following manner. A pressure sensor attached to a handle of a slide control element mounted on the keyboard of the musical sound control device detects the intensity of a pressure that a player holds the handle, and a bow pressure is controlled according to this detection. Also, a bow velocity is controlled according to a detection of the velocity that a player slides the slide control element.

[Problem to be Solved by the Invention]

By the way, because the mentioned conventional slide control

element, as illustrated in FIG. 19, has a structure such that a magnet 19 is slid through a coil 18 winded certain times, it must be fixed on a keyboard and so forth, there was a drawback such that an installment place was restricted.

The present invention is made considering the circumstance mentioned above, and the purpose is to provide a musical sound control device including a performance control element freely controlled without a restriction with an installment place and being able to achieve a sound control responding to free motions of a player.

[Means for Solving the Problem]

The present invention is characterized by including:

an acceleration detecting means for detecting an acceleration of a motion given to a performance control element and outputting an acceleration signal; a pressure detecting means for detecting a pressure given to the performance control element and outputting a pressure signal; and a control means for outputting musical sound control data for controlling a musical sound signal based on the acceleration signal and the pressure signal, and outputting musical sound control data for damping the musical sound signal in the case that the acceleration signal or the pressure signal from the acceleration detecting means or the pressure detecting means is not output.

[Operator]

According to the present invention, when a player gives a certain motion or pressure to the performance control element, the acceleration detecting means detects an acceleration of a motion on the performance control element and outputs an acceleration signal. Also, the pressure detecting means detects a pressure given to the performance control element and outputs a pressure signal.

Therefore, a control means outputs musical sound control data for controlling a musical sound signal based on an acceleration signal and a pressure signal.

Further, when a player stops giving a motion or a pressure to the performance control element, and an acceleration signal or a pressure signal stops being output from the acceleration detecting means or the pressure detecting means, the control means outputs musical sound control data for damping the musical sound signal.

[Embodiment]

Hereinafter, an embodiment of the present invention will be

described with reference to the attached drawings. FIG. 2 is a schematic perspective view for illustrating a configuration of a performance control element used in a musical sound control device according to a first embodiment. In this figure, reference numerals 1_1 through 1_3 are attached to an end of a stick 2, and are acceleration sensors for detecting each acceleration in X-direction, Y-direction, and Z-direction.

Here, in FIG. 3 (a) and (b), a front cross sectional view and a top plan view of an external appearance configuration of an acceleration sensor 1 will be illustrated. In this acceleration sensor 1, donut-shaped piezoelectric elements 4_1 and 4_2 are fitted into an axis part 3a so that the piezoelectric elements 4_1 and 4_2 touch the inside of flange parts 3b and 3c of a frame 3 wherein the flange parts 3b and 3c are integrally formed on both ends of the axis part 3a, and a weight 5 is movably inserted into the axis part 3a between the piezoelectric elements 4_1 and 4_2. When a player swings the stick 2, the weight 5 moves in the direction l or the direction m in the figure, and pushes the piezoelectric elements 4_1 or 4_2. Therefore; an acceleration signal corresponding to an acceleration is output from this acceleration sensor 1. Further, an acceleration signal is a difference between each output signal by the piezoelectric elements 4_1 and 4_2. This is for an acceleration signal to become 0 when a player stops swinging the stick 2, that is, for being able to detect an acceleration at the moment that the swinging of the stick 2 stops.

Also, in FIG. 2, a reference numerals 6 is a pressure sensor attached to a grip 7 inserted into the other end of the stick 2.

Next, a block diagram of the configuration of a musical sound control device according to the first embodiment of the present invention will be illustrated in FIG. 1. In this figure, the same reference numeral is given to the part corresponding to each part in FIG. 2, and an explanation about it will not be provided. In FIG. 1, a reference numeral 8 is a keyboard including plurality of keys for detecting keys pushed and outputting the key codes KC corresponding to the keys. A reference numeral 9 is an A/D converter for converting analog acceleration signal output from each of the acceleration sensors 1_1 through 1_3 and the pressure sensor 6 into digital data.

Also, a reference numeral 10 is a microcomputer having one chip

wherein a CPU (Central Processing Unit), a program ROM, a RAM for temporarily storing various data, and an I/O interface are built in. A reference numeral 11 is a string-rubbing model sound source among the physical model sound source mentioned above. A reference numeral 12 is a D/A converter for converting musical sound data output from the physical model sound source 11 into analog musical sound signals. A reference numeral 13 is a sound system including an amplifier, a speaker and the like where musical sound signals are input and a musical sound is produced.

With this configuration, an operation of a CPU within the microcomputer 10 in the case that a player performs using the keyboard 8 and swings the performance control element in FIG. 2 in a space will be described based on the flowcharts in FIGs. 4 through 10.

When power source is provided to a musical sound control device 1 shown in FIG. 1, the CPU within the microcomputer 10 proceeds to a process of the step SA1 in FIG. 4, and initializes each part of the device. This initialization is setups of an initial tone in the physical model sound source 11, interfaces of the keyboard 8, the acceleration sensors 1_1 through 1_3, the pressure sensor 6, and the like and clearing of a working memory. Then, the process goes to the step SA2.

In the step SA2, a key process is executed at the moment that any one of the keys on the keyboard 8 is turned on. The routine of this key process is shown in FIG. 5. In the step SB1 of this routine, after key codes KC output from the keyboard 8 is stored in a register KCD, the process returns to the main routine, and goes to the step SA3.

In the step SA3, a tone switch process for detecting a turned-on condition of a tone switch (not shown) for selecting each tone is made. The routine of this tone switch process is shown in FIG. 6. In the step SCI of this routine, after codes of the tone switch turned on are stored in a register TC, the process goes to the step SC2.

In the step SC2, parameters to be controlled by the physical model sound source 11 (parameters such as for filters and nonlinear elements) stored together about each code in the ROM within the microcomputer 10, are read out according to values of the register TC to send to the physical model sound source 11. Thereby, each parameter of each tone of the physical model sound source 11 is set up, and a tone changes. Then, CPU returns its process to the main

routine and goes to the step SA4.

In the step SA4, output signal of each sensor 1_1 through 1_3 and 6 of the performance control element is detected, and a performance control element process for controlling each parameter of the physical model sound source 11 is made according to the output signal.

In this performance control element process, the detection of an output signal of each sensor 1_1 through 1_3 and 6 of the performance control element and a control of each parameter of the physical model sound source 11 according to the output signal are made with timing in a certain interval. So an n-bit counter TIME is provided for counting a timing in predetermined interval.

The routine of this performance control element process is shown in FIG. 7. In the step SDI of this routine, a judgment is made about if a carry-occurring flag TF where 1 is set in the case a carry occurs in the counter TIME mentioned above is 1 or not. If the judgment result is "NO", the process goes to the step SD2.

In the step SD2, a judgment is made about if a value of a free-running n-bit counter CNT is larger than a value of the counter TIME or not. This counter CNT counts up by a timer interruption process made in every certain time interval. The routine of this timer interruption process will be illustrated in FIG. 8. In the step SE1 of this routine, after 1 is added to increment a value of the counter CNT, the process returns to the main routine. If the judgment result is "NO" in the step SD2, the process returns to the main routine, and returns to the step SA2.

However, if the judgment result is "YES" in the step SD2, the process goes to the step SD3.

In the step SD3, a performance control element data input process is made. That is, each datum output from each sensor 1_1 through 1_3 and 6 of the performance control element and converted into digital data at the A/D converter 9 are stored in the RAM. Namely, data of the X-direction acceleration sensor 1_1, data of the Y-direction acceleration sensor 1_2, data of the Z-direction acceleration sensor 1_3, and data of the pressure sensor 6 are respectively stored in a register AX in the RAM, a register AY in the RAM, and a register AZ in the RAM, and the register TS in the RAM. Then the process goes to the step SD4.

In the step SD4, a sound source parameter producing process for producing parameters to be sent to the physical model sound source

11 is made. The routine of this sound source parameter producing process is shown in FIG. 9. In the step SFI of this routine, after 1 is as an initial value in a flag ZF where 1 is set when the accelerations of all the acceleration sensors 1_1 through 1_3 for X-direction, Y-direction and Z-direction are 0, the process goes to the step SF2.

In the step SF2, a judgment about if a value stored in the register AX is smaller than a preset threshold value TA or not is made. If the judgment result is "YES", the process goes to the step SF3.

In the step SF3, after 0 is stored in the register AX, the process goes to the step SF5.

However, if the judgment result in the step SF2 is "NO", the process goes to the step SF4.

In the step SF4, after a flag ZF is reset to 0, the process goes to the step SF5.

In the step SF5, a judgment about if a value stored in the register AY is smaller than a preset threshold value TA or not is made. If the judgment result is "YES", the process goes to the step SF6.

In the step SF6, after 0 is stored in the register AY, the process goes to the step SF8.

However, the judgment in the step SF5 is "NO", the process goes to the step SF7.

In the step SF7, after a flag ZF is reset to 0, the process goes to the step SF8.

In the step SF8, a judgment about if a value stored in the register AZ is smaller than a preset threshold value TA or not is made. If the judgment result is "YES", the process goes to the step SF9.

In the step SF9, after 0 is stored in the register AZ, the process goes to the step SF11.

However, the judgment result in the step SF8 is "NO", the process goes to the step SF10.

In the step SF10, after a flag ZF is reset to 0, the process goes to the step SF11.

In the step SF11, each acceleration in X-direction and Y-direction is integrated and each velocity is obtained. Therefore, VX + AX (acceleration data in X-direction) is substituted for an X

velocity variable VX for indicating a velocity in X-direction, and VY + AY (acceleration data in Y-direction) is substituted for a Y velocity variable VY for indicating a velocity in Y-direction. This process, by performing a summation of accelerations, alternates for the integration of the acceleration. Then, the process goes to the step SF12.

In the step SF12, a magnitude of a composite vector of each velocity in X-direction and Y-direction (□VX^2 + VY^2) is let a bow velocity v that is a parameter of the physical model sound source 11, and a value stored in the register TS, that is, data corresponding to an output signal of the pressure sensor 6 is also let a bow pressure p that is a parameter of the physical model sound source 11. Then, the process goes to the step SF13.

In the step SF13, acceleration data in Z-direction stored in the register AZ is used for detune (a function for slight off-pitching) data of the physical model sound source 11. Therefore, as indicated in next formula, a product of detune DD(AZ) that detune DD is changed corresponding to a value of AZ and a delay length DL(KCD) corresponding to key codes KC stored in the register KCD is let a delay length D of a delay of the physical model sound source 11. This makes a delay length D a delay length with a detune.

D □ DD(AZ) × DL(KCD) ...... (1)

Then the process goes to the step SF14.

In the step SF14, after each datum of a bow velocity v, a bow pressure p, and a delay length D is sent out to the physical model sound source 11, the process returns to the routine of the performance control element process in FIG. 7.

In the step SD5 of the routine of the performance control element process in FIG. 7, a DC correction filtering process is made.

Due to an obtainment of a velocity by an integration of acceleration data in the routine of the mentioned sound source parameter producing process or a dispersion of each element of l_1 through l_3 in acceleration sensors, if the performance control element is stopped after swinging, negative data should be obtained as acceleration data. However, if a velocity is obtained by an integration of those data, the value is not necessarily 0. Thus, this correction process is made.

The routine of this DC correction filtering process is shown in FIG. 10. In the step SG1 of this routine, a judgment is made about

if 1 is set on a flag ZF, that is, if all accelerations in X-direction, Y-direction and two directions are 0 or not. If the judgment result is "YES", the process goes to the step SG2.

In the step SG2, VX x FC (0 < FC < 1) is substituted for an X velocity variable VX, and VY x FC is substituted for a Y velocity variable VY for indicating a velocity in Y-direction. This process is a process for damping a velocity, and is a process equivalently providing a function equal to a bypass filter. Then, the process returns to the routine of the performance control element process in FIG. 7.

However, if the judgment result in the step SG1 is "NO", that is, if any one of accelerations in X-direction, Y-direction, and Z-direction is not 0, the process returns to the routine of the performance control element process in FIG. 7 without doing anything. This is for the case that a musical sound is wanted to be sustained.

In the step SD6 of the routine of the performance control element process in FIG. 7, after a timing interval ΔT ($\Delta T < 2^{n-1}$) is incremented to a value of the counter TIME, the process goes to the step SD7.

In the step SD7, a judgment about if a carry has occurred in the counter TIME or not is made. If the judgment result is "NO", the process returns to the main routine, and then returns to the step SA2.

However, if the judgment result in the step SD7 is "YES", the process goes to the step SDB.

In the step SD8, after 1 is placed on the carry-occurring flag TF, the process returns to the main routine, and then returns to the step SA2.

If the judgment result in the step SD1 of a computation operator process in FIG. 7 is "YES", that is, if 1 is set on the carry-occurring flag TF, the process goes to the step SD9.

In the step SD9, a judgment is made about if the most significant number of the counter CNT is "0" or not. The judgment result returns to the main routine of "NO", the process returns to the step SA 2.

However, the judgment result in the step SD9 is "YES", the process goes to the step SD10.

In the step SD10, after the carry-occurring flag TF is reset to 0, the process returns to the main routine, and then returns to step SA2.

With the each process described above being made, responding

to the performance that a player performs using the keyboard 8 and a motion of the performance control element that a player swings in a space, parameters of the physical model sound source 11, in this case, parameters such as the bow velocity v, a bow pressure p, and a delay length D of the string-rubbing model sound source are controlled, musical sound data are output from the physical model sound source 11, and after they are converted into a musical sound signal in the D/A converter 12, a musical sound is output from the sound system 13.

Further, in a sound source parameter process in the mentioned first embodiment, an example is described such that a set / reset of the flag ZF is made in the case that the outputs of the acceleration sensors 1_1 through 1_3 exceed a certain threshold value, but it also can be done in the case that an output of the pressure sensor 6 exceeds a certain threshold. This is more effective because a player can make an arbitrary setup. Here, a sound source parameter producing process in that case will be described based on the flowchart in FIG. 11.

In the step SF101 of this routine, after VX + AX is substituted for an X velocity variable VX and VY + AY is substituted for a Y velocity variable VY, the process goes to the step SF102.

In the step SF102, a judgment is made about if a value stored in the register TS is smaller than a preset threshold value TP or not. If the judgment result is "YES", the process goes to the step SF103.

In the step SF103, after 1 is set on the flag ZF and 0 is stored in the register TS, the process goes to the step SF105.

However, the judgment result in the step SF102 is "NO", the process goes to the step SF104.

In the step SF104, after the flag ZF is reset to 0, the process goes to the step SF105.

In the step SF105, after a magnitude of a composite vector of each velocity in X-direction and Y-direction (□VX^2 + VY^2) is let a bow velocity v and a value stored in the register TS is let a bow pressure p, the process goes to the step SF106.

In the step SF106, as indicated in the formula (1) mentioned above, after a product of detune DD(AZ) that detune DD is changed corresponding to a value of AZ and a delay length DL(KCD) corresponding to key codes KC stored in the register KCD is let a delay length D,

the process goes to the step SF107.

In the step SF107, after each datum of a bow velocity v, a bow pressure p and a delay length D is sent to the physical model sound source 11, the process returns to the routine of the performance control element process in FIG. 7.

Also, if a switch is placed separately, an arbitrary set / reset of the flag ZF by a player is possible.

Further, in a DC correction filtering process in the mentioned first embodiment, an example is described such that a velocity is damped in the case that 1 is set on the flag ZF . However, as illustrated in the flowchart in FIG. 12, a velocity may be damped regardless of set / reset of the flag ZF, and as illustrated in the flowchart in FIG. 13, velocities VX and VY may also be let 0 in the case that 1 is set on the flag ZF. In the latter case, because a natural damping of musical sound data is made in the physical model sound source 11 if velocities VX and VY are let 0 immediately, there is no problem.

In addition, in a DC correction filtering process in the mentioned first embodiment, an example is described such that each of velocities VX and VY is multiplied by a certain value FC for damping a velocity. However, instead of that, a value of a velocity datum expressed in binary scale may be shifted down by 1 bit to be 1/2.

Also, in the mentioned first embodiment, an example is described such that a string-rubbing model sound source is used as a physical model sound source 11. However, a physical model sound source of a wind instrument (hereinafter refered to wind model sound source) may be used. Here, a sound source parameter producing process and a DC correction filtering process in the case of using a wind model sound source will be described with reference to the flowcharts in FIGs. 14 and 15.

In the step SF201 of the routine of a sound source parameter producing process in FIG. 14, after VX + AX is substituted for an X velocity variable VX and VY + AY is substituted for a Y velocity variable VY, the process goes to the step SF202.

In the step SF202, PX + VX is substituted for an X displacement variable PX, and PY + AY is substituted for a Y displacement variable PY. Because parameters to be controlled by the wind model sound source, breath pressure and an embouchure, have displacements, displacements PX and PY are obtained by second integrations of

accelerations AX and AY. Then, the process goes to the step SF203.

In the step SF203, a judgment is made about if a value stored in the register TS is smaller than a preset threshold value TP or not. If the judgment result is "YES", the process goes to the step SF204.

In the step SF204, after 1 is set on the flag ZF and 0 is stored in the register TS, the process goes to the step SF206.

However, the judgment result in the step SF203 is "NO", the process goes to the step SF205.

In the step SF205, after the flag ZF is reset to 0, the process goes to the step SF206.

In the step SF206, after a Y displacement variable PY is converted into embouchure data E based on a converting table between displacement P and embouchure E, which is stored within the ROM or RAM beforehand, the process goes to the step SF207.

In the step SF207, after a X displacement variable PX is converted into breath pressure data B based on a converting table between displacement P and breath pressure B, which is stored within the ROM or RAM beforehand, the process goes to the step SF208.

In the step SF208, as indicated in the formula (1) mentioned above, after a product of detune DD(AZ) that detune DD is changed corresponding to a value of AZ and a delay length DL(KCD) corresponding to key codes KC stored in the register KCD is let a delay length D, the process goes to the step SF209.

In the step SF209, after each datum of an embouchure E, a breath pressure B, and a delay length D is sent to the physical model sound source 11, the process returns to the routine of the performance control element process in FIG. 7.

Next, a DC correction filtering process in FIG. 15 will be described. In the step SG301 of this routine, a judgment is made about if 1 is set on the flag ZF or not, that is, if all the acceleration in X-direction, Y-direction and Z-direction are 0 or not. If the judgment result is "YES", the process goes to the step SG302.

In the step SG302, after 0 is substituted for an X velocity variable and a Y velocity variable, the process goes to the step SG303.

In the step SG303, after PX x FC ($0 < FC < 1$) is substituted for an X displacement variable PX and PY x FC is substituted for a Y displacement variable PY, the process returns to the routine of the performance control element process in FIG. 7.

However, if the judgment result in the step SG301 is "NO", that is, if any one of accelerations in X-direction, Y-direction, or Z-direction is not 0, the process returns to the routine of the performance control element process in FIG. 7 without doing anything.

In addition, in the mentioned first embodiment, an example is described such that the acceleration sensors 1_1 through 1_3 for X-direction, Y-direction and Z-direction are attached to the stick 2 of the performance control element in FIG. 2 and a 3-dimensional acceleration is detected. However, one or two of these acceleration sensors 1_1 through 1_3 may be removed so that a 2-dimensional or 1-dimensional acceleration is detected.

Further, in the case of detecting a 1-dimensional acceleration, for example, a white line may be drawn on a wall or a wire may be stretched in a space for moving the performance control element along the white line or the wire. In this case, an output signal of the acceleration sensor is used for controlling a parameter about a velocity of the physical model sound source 11 (for example, a bow velocity).

Also, in the case of detecting a 2-dimensional acceleration, an output signal of an acceleration sensor corresponding to a motion of the performance control element in the horizontal direction is used, for example, for controlling a parameter about a velocity of the physical model sound source 11 (for example, a bow velocity), and an output signal of an acceleration sensor responding to a motion of the performance control element in the vertical direction is used, for example, for controlling a parameter about a displacement of the physical model sound source 11 (for example, a bow pressure).

In addition, in the mentioned first embodiment, an example is described such that the pressure sensor 6 is attached to the grip 7 inserted into the other end of the stick 2 and a pressure that a player holds the grip 7 is detected. However, the pressure sensor 6 may be attached to the end of the stick 2 where the acceleration sensors 1_1 through 1_3 are attached, and a player may rub the part of the sensor 6 with a wall and so forth.

In addition, in the mentioned first embodiment, an example is described such that a magnitude of a composite vector of accelerations in X-direction and Y-direction is used for controlling a bow velocity of the physical model sound source 11 and an acceleration in Z-direction is used for controlling a detune with a delay length D.

However, an application is not limited to this. For example, a magnitude of a composite vector of all accelerations in X-direction, Y-direction, and Z-direction may be used for controlling a bow velocity of the physical model sound source 11.

Also, in the mentioned first embodiment, an example is described such that each acceleration in X-direction, Y-direction and Z-direction is detected by the acceleration sensors 1_1 through 1_3. However, each angle velocity around X-axis, Y-axis, and Z-axis may be detected.

Next, a second embodiment of the present invention will be described. FIG. 16 is a perspective view for illustrating an external appearance configuration of a performance control element used in a musical sound control device according to a second embodiment of the present invention. In this figure, a reference numeral 14 is an operating board including a plurality of v-shaped grooves 14_1 through 14_4 whereby each groove has a different angle, a reference numeral 15 is a handheld-part including a pyramid part. When a player slides the pyramid part in a direction p or a direction q in the figure while pushing the pyramid part onto any one of the grooves 14_1 through 14_3 on the control panel 14, a signal responding to the operation is output. Here, FIG. 17 (a) and (b) show a front view and a side view of an external appearance configuration of the handheld-part 15. In this figure, a reference numeral 16 is an acceleration detector attached to a side of the handheld-part 15, and reference numerals 17_1 and 17_2 are pressure sensors individually attached to the slopes of the pyramid part.

Next, FIG. 18 shows block diagram of a configuration of a musical sound control device according to a second embodiment of the present invention. In this figure, the same reference numeral is given to the part corresponding to each part in FIGs. 3 and 17, and explanations will not be provided.

In such a configuration, for example, in the case of using a string-rubbing model sound source as the physical model sound source 11, two systems of a string-rubbing model sound source are provided for the pressure sensor 17_1 and the pressure sensor 17_2. Among parameters to be controlled by each string-rubbing model sound source, a bow velocity is commonly controlled based on a output signal of the acceleration sensor 16, and a bow pressure is controlled respectively based on an output signal from each of the acceleration

sensors 17_1 and 17_2. In addition, a specific action of each part of the device is the same as the mentioned first embodiment, and explanations will not be provided.

As described above, because the handheld-part 15 can be slid on the control panel 14, the operability is, compared with a conventional slide control, improved such that the way of pushing the handheld-part 15 onto the control panel 14 can be freely changed. Also, control of parameters of the physical model sound source is not monotonous, so is devised in various ways.

Further, in the mentioned second embodiment, an example is described such that the control panel 14 is shaped horizontally flat. However, a curvature may be given to the control panel 14 for enabling the handheld part 15 to smoothly slide for improving the operability.

[Effect of the Invention]

As described above, according to the present invention, there is an effect such that an inclusion of a performance control element that is not restricted with an installment place and can be operated freely and a musical sound control responding to free motions of a player are achieved.

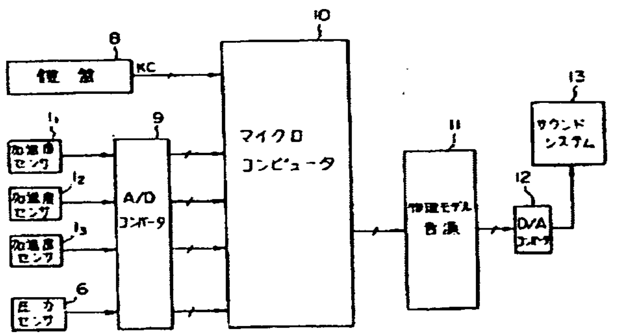
Also, there is an effect such that conventionally unobtainable and novel performance effects and a novel performance operation can be provided and the degree of freedom for sound making is high.

4. Brief Description of Drawings

FIG. 1 is a block diagram showing a configuration of a musical sound control device according to a first embodiment of the present invention. FIG. 2 is a schematic perspective view showing a configuration of a performance control element used in the embodiment. FIG. 3 (a) and (b) are front cross sectional view and a top plan view illustrating an external appearance configuration of an acceleration sensor 1, respectively. FIGs. 4 through 15 are flowcharts showing actions of a CPU within the microcomputer 10. FIG. 16 is a perspective view showing an external appearance configuration of a performance control element used in a musical sound control device according to a second embodiment of the present invention. FIG. 17 (a) and (b) are a front view and a side view of an external appearance configuration of the handheld-part 15, respectively. FIG. 18 is a block diagram showing a configuration of a musical sound control device according to a second embodiment of the present invention. FIG. 19 is a figure illustrating a schematic configuration of a

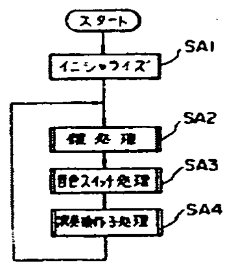
conventional slide control.

1_1 through 1_3 , and 16: acceleration sensors, 6, 17_1, and 17_2: pressure sensors, 10: microcomputer, 11: physical model sound source, 14: control panel, 15: handheld part.

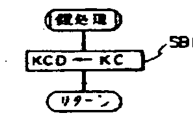


第1図

Acceleration sensor	1_1～1_3
Pressure sensor	6
Keyboard	8
A/D converter	9
Microcomputer	10
Physical model sound source	11
D/A converter	12
Sound system	13



第4図



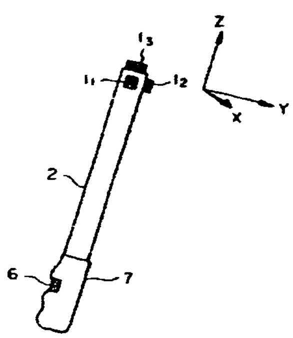
第5図

FIG. 4

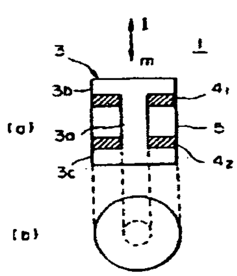
Start	なし
Initialize	SA1
Key process	SA2
Tone switch process	SA3
Performance operator process	SA4

FIG.5

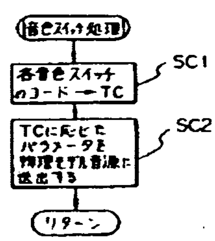
Key process	
Return	



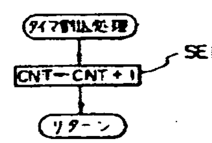
第2図



第3図



第6図



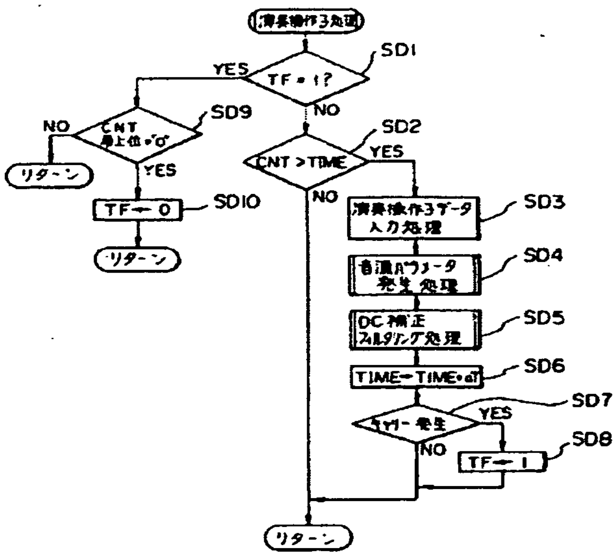
第8図

FIG. 6

Tone switch process	
Switch code of each tone	SC1
Send parameters corresponding to TC to physical model sound source	SC2
Return	

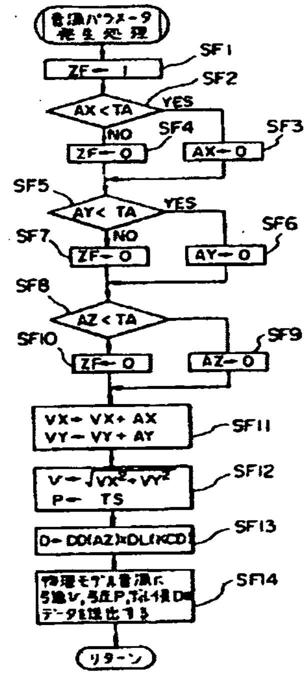
FIG. 8

Timer interruption process	
Return	



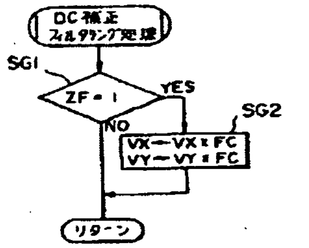
第7図

Performance operator process	
Performance operator data input process	SD3
Sound source parameter producing process	SD4
DC correction filtering process	SD5
Carry occurring	SD7
Most significant number of CNT = "0"	SD9
Return	

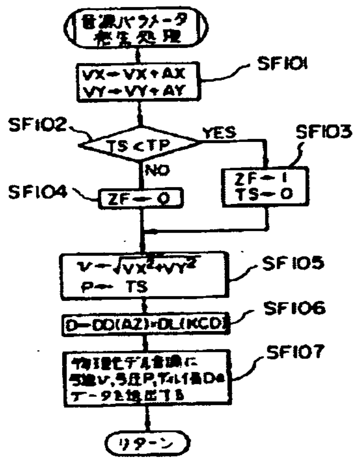


第9図

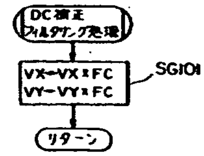
Sound source parameter producing process	
Send data of a bow velocity v, a bow pressure p, and a delay length D to physical model sound source	SF14
Return	



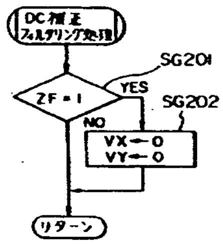
第10図



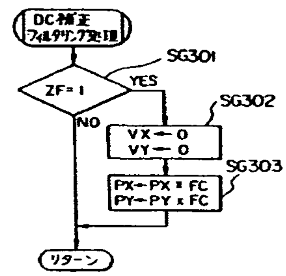
第11図



第12図



第13図



第15図

FIG. 10

DC correction filtering process	
Return	

FIG. 11

Sound source parameter producing process	
Send data of a bow velocity v, a bow pressure p, and a delay length D to physical model sound source	SF107
Return	

FIG.12

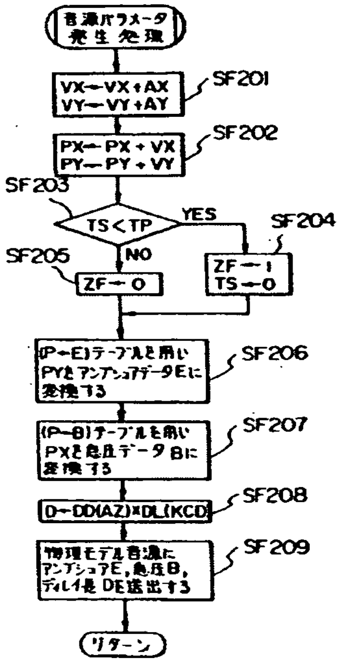
DC correction filtering process	
Return	

FIG.13

DC correction filtering process	
Return	

FIG.15

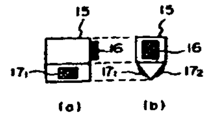
DC correction filtering process	
Return	



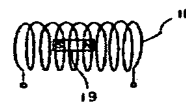
第14図

Sound source parameter producing process	
Convert PY into embouchure data E using (P ◘ E) table	SF2 0 6
Convert PX into breath pressure data B using (P ◘ B) table	SF2 0 7
Send embouchure E, breath pressure B, and delay length D to physical model sound source	SF2 0 9
Return	

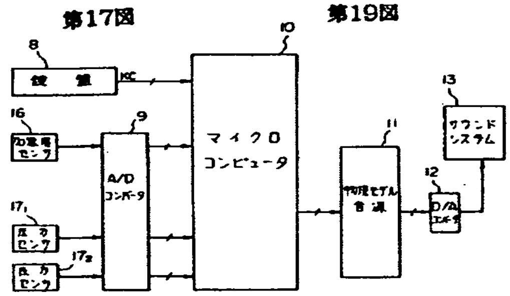
第16図



第17図



第19図



第18図

Keyboard	8
A/D converter	9
Microcomputer	1 0
Physical model sound source	1 1
D/A converter	1 2
Sound system	1 3
Acceleration sensor	1 6
Pressure sensor	17_1、17_2